RECENT VIRAL OUTBREAKS AND THEIR CONSEQUENCES IN INDIA

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CERTIFICATE

Certified that the dissertation entitled "**RECENT VIRAL OUTBREAKS AND THEIR CONSEQUENCES IN INDIA**" has been carried out entirely by Doyel Chatterjee, student of SEM VI, B.Sc. (Gen) in the Department of Botany, MUC Women's College, Burdwan University, Purba Bardhaman under my supervision. It is further certified that the candidate has fulfilled all the conditions necessary for the partial fulfillment of her B.Sc. (Gen) degree achievement under this University and this work has not been submitted anywhere for any other degree to the best of my knowledge.

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INDEX

Introduction

Viral diseases are the most crucial biological threat to the human kind. In recent past human civilization have witnessed out breaks of many deadly viruses. In the present dissertation aimed to focus on such three deadly virus diseases, viz. Corona virus, Adenovirus, and Dengue. Disease symptoms, mode of dissemination, and disease preventions were also categorically discussed.

World health organization (WHO) declared the "COVID-19"as a pandemic disease on the planet. Origin of Covid-19 is from Wuhan, China. In all over the world the number of patients infected with Covid-19 reached 36,20,773 and total death 2,50,811 have been recorded till date. In USA the total number of corona patients reached 12,00,884 and total death 69,121 recorded (Msemburi et al., 2023). In India total number of corona patients has reached 45,005, and total death 1,466 recorded till date (Msemburi et al., 2023). European Central banks have little ammunition with which to deal with the Corona Virus Pandemic. Viruses of the family Corona virus is enveloped and their nucleocapsid is patchy. The conspicuous aster, formed by an arrangement of spikes extending outward from the electron-microscope. In Latin, corona means crown. That is why these viruses are named as coronaviruses. These viruses cause colds. A deadly human-killing coronavirus (CoV-SARS) that causes respiratory infections in humans is called SARS from severe acute respiratory syndrome (Qiu et al., 2020). In November 2002, SARS virus emerged in China. Another emerging infectious disease similar to CoV-SARS is COVID-19, Here CO stands for Corona, VI stands for Virus, D stands for Disease and 19 stands for 2019, first seen in Wuhan, China (Singhal, 2020). COVID-19 then spread around the world and caused many deaths. So, viruses of the genus Corona viridae cause three respiratory diseases: the common cold, SARS, and COVID-19.

On the other hand, Adenovirus were first is located in 1935 from adenoid tissues Adenoviruses have historically illness in military recruits (Edward et al., 1985). Adenoviruses can replicate and procedure disease respiratory gastrointestinal and procedure trait and in the eye. Many adenovirus infections are subclinical and virus persist in hosts for cancer induction in animals. Adenoviruses are especially valuable systems for molecular and especially valuable systems for molecular and biochemical studies of

eukaryotic cell processes. Adenoviruses have historically been a common cause of acute respiratory illness in military recruits. The adenoviruses are common pathogens of humans and animals more than 100 serologically distinct types of adenoviruses have been identified, including 49 types Adenovirus is a group of medium sized non enveloped double stranded DNA viruses that replicate and produce disease in the eye and in the respiratory, gastrointestinal and urinary tracts originally isolated from adenoids (Edward et al., 1985). At least forty-seven serotypes, Associated with human disease (Edward et al., 1985). Adenoviruses are a group of medium sized non enveloped double stranded. DNA viruses that share a common complement fixing antigen they infected humans and animals. Many adenoviruses infection is subclinical virus persists in hosts for months. Adenoviruses typically caves mild cold-or-flu like illness adenoviruses can cause illness in people of all ages any time of year. People with weakened immune systems, existing respiratory or cardiac disease at higher risk of developing sever illness from an adenoviruses infection. Acute respiratory disease this disease is caused by adenoviruses: serotypes 4 and 7 fever rhinorrhea, cough and sour throat are the typical symptoms which last for 3 to 5 days (Edward et al., 1985). This syndrome most often affects military recruits living in crowded conditions pharynges conjunctival fever this syndrome occurs primarily in school going children fever, sour throat crazy and red eye are the classic presentation of the condition**.** Within the last two and half months more than 100 children lost their lives due to the Adenoviruses infected disease named acute respiratory infection. Adenoviridae is a group of medium sized, non-enveloped, double stranded DNA viruses that replicate and produce disease in the eye and in the respiratory, gastrointestinal and urinary tracts (Cruz et al., 2019). Isolated originally from adenoids. At least 47 serotypes linked to human disease The majority of infections are asymptomatic, prevalent in children, and may be subclinical with long-lasting virus persistence in the host. The majority of human adenovirus diseases are caused by one-third of the 51 serotypes, while a few serotypes are used to induce cancer in animal models. Adenoviruses have double-stranded DNA and are encased in a polypeptide Icosahedral capsid that is not enclosed and has a gnycoprotein projection. Most cases of adenovirus eye illness exhibit one of the following three classic syndromes clinically: (1) Simple follicular conjunctivitis (several serotypes), (2) Conjunctival fever in the pharynx, and (3) A widespread kerato conjunctivitis (Edward et al., 1985).

Nowadays many people suffer from dengue fever which is an infectious disease carried by mosquitoes and is caused by any four related dengue viruses. The disease used to be called breakbone fever because it sometimes Causes severe joint and muscle pain (Howe et al., 1977). Dengue fever is a quite dangerous disease can be found in the tropics and Africa. Dengue fever is transmitted by Aedes Aegypti mosquito, which also transmits disease as yellow fever. Dengue or Dengue like epidemics were reported throughout 19th and early 20th centuries in America, Southern Europe, North Africa the eastern Mediterranean, Asia and Australia and Various (Gubler et al., 1997). Island in the Indian Ocean, the South and Central Pacific and the Caribbean. Annually it is estimated that there are 20 million Cases of dengue infection resulting in around 24,000 deaths (Sah et al., 2023). Dengue fever is flu like viral disease common throughout the tropical and subtropical regions around the world, mainly in urban and pre-urban areas.

Coronavirus

ORIGIN OF CORONAVIRUS

Wuhan, China, received the first reports of Covid-19 in December 2019 (Msemburi et al., 2023). In 2020, the World Health Organization declared that the disease was pandemic and that the virus had spread to almost every country. The corona virus is often referred to as sarscovid-2. It has long been believed that the coronavirus (CoV) is a virus with a high risk of spreading. SARS-CoV-2, the seventh coronavirus to be discovered in the last 20 years and the ninth coronavirus to infect humans, has spread at an unprecedented rate (Lednicky et al., 2021; Vlasova et al., 2022). All prior strains of the human coronavirus are zoonotic in origin, as are the majority of human virus strains (Holmes et al., 2021). Since the late 1930s, various animal coronaviruses (CoVs) have been identified, including the bovine coronavirus (BCoV), porcine transmissible gastroenteritis virus (TGEV), infectious bronchitis virus (IBV), and feline infectious peritonitis virus (FIPV) (Saif, 2004). Recent research has connected the emergence of human CoVs (HCoVs) to a high level of urbanization and poultry breeding, which promotes the exchange of species and makes species crossover easier.

In China's Guangdong province, Foshan had the first SARS-CoV cases in November 2002 (Ge, Hu, & Shi, 2015). With 8096 cases and 774 fatalities, it finally developed into a SARS epidemic that affected 28 different nations (Ge et al., 2015). Investigations revealed that masked civet cats and raccoon dogs were the first animals to contract the SARS-CoV virus. Later, at a live animal market in Shenzhen, China, antibodies to the virus were discovered in a badger. These antibodies were thought to be the cause of the human infection (Drexler et al., 2014; Guan et al., 2003; Song et al., 2019). Furthermore, genetically distinct SARS-CoVs were discovered in Chinese rhinophid bats (*Rhinolophus* spp.), suggesting that these animals are hosts for the virus (Lau et al., 2005; Li et al., 2005) HCoV Epidemiological research indicates that the Huanan Market in Wuhan was the primary and initial epicenter of the SARS-CoV-2 epidemic. 28% of all cases reported in December 2019 had a direct connection to the market, which was also responsible for two of the first three instances of COVID-19 to be identified (WHO, 2021). About 55% of the cases in December 2019 involved contact with other marketplaces in

Wuhan, and these cases were concentrated mainly in the first fifteen days of December (WHO, 2021). An examination of the sites revealed that early cases were primarily found close to the Huanan Market, which served as the foundation for identifying the epidemic site. In January 2020, these areas were the first to observe an increase in pneumonia mortality, a statistic less susceptible to reporting error (Holmes et al., 2021). Due to higher occult transmission rates and undetected secondary transmissions, there may be cases in the early phases of the epidemic that do not seem to have a clear connection to the market. A similar situation was demonstrated in early SARS-CoV cases (Xu et al., 2004). However, thorough examinations in other locations and nations will determine whether the first infection case in the Huanan Market is actually the first incidence of SARS-CoV-2 infection worldwide.

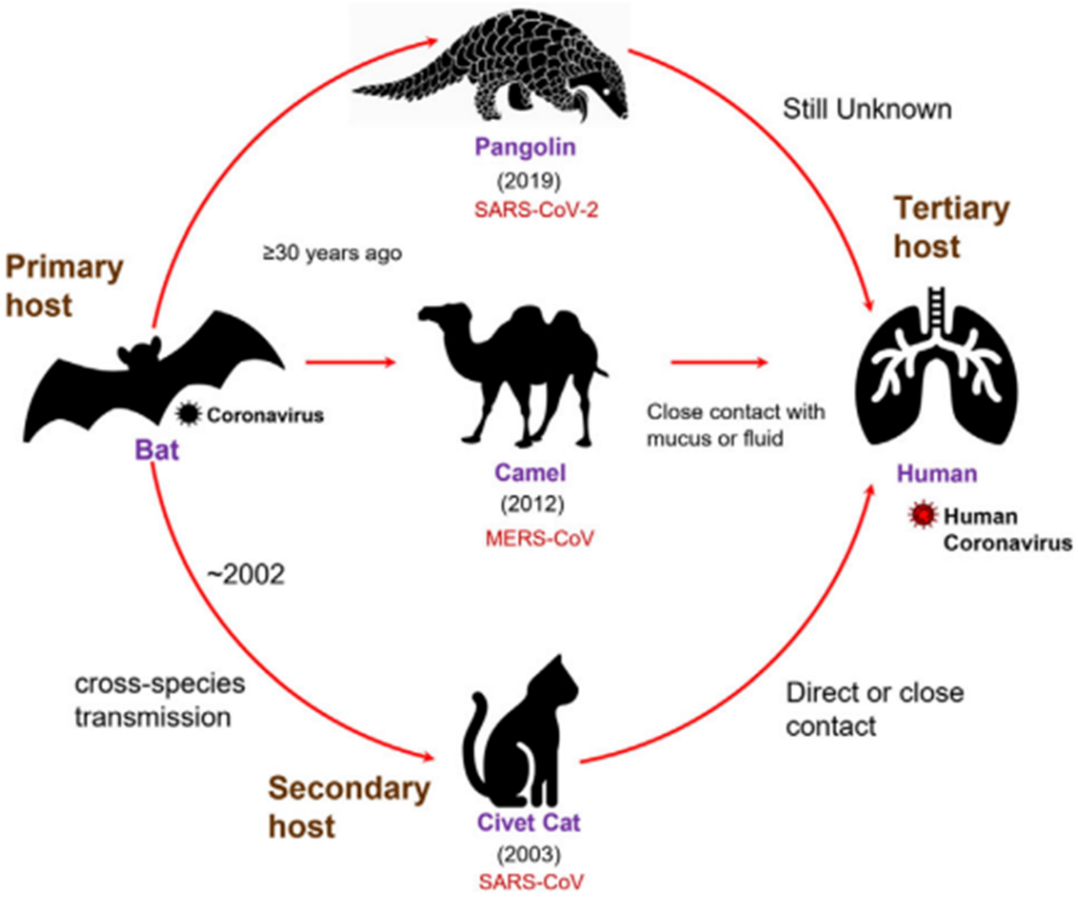

FIGURE 1: Schematic diagram of the transmission process of three HCoVs. Humans acquired SARS-CoV and MERS-CoV from bats through civet cats and dromedary camels, respectively. It is unclear how SARS-CoV-2 spread to humans (Xu et al., 2004)

STRUCTURE OF CORONAVIRUS

Corona viruses are architecturally a sizable family of RNA viruses. Corona literally translates to "crown," therefore the name makes sense. The name of this family of viruses comes from its resemblance to a king's crown under an electron microscope. Like all other viruses, they can only exist and reproduce within an animal or plant cell. A protective capsid, which is a lattice of repeating protein molecules known as the coat or capsid proteins, surrounds the long RNA polymers that are firmly packed into the centre of coronavirus particles. These proteins are known as nucleocapsids (N) in coronaviruses. An additional outer membrane envelope consisting of lipids (fats) with proteins inserted surrounds the coronavirus core particle. These modified membranes, which include the spike (S), membrane (M), and envelope (E) proteins, are derived from the cells where the virus was most recently formed. Spike proteins (S) are a crucial subset of the outer membrane proteins that protrude from the particle. These proteins are the ones that are recognised by receptor proteins on the infected host cells (Li et al., 2016).

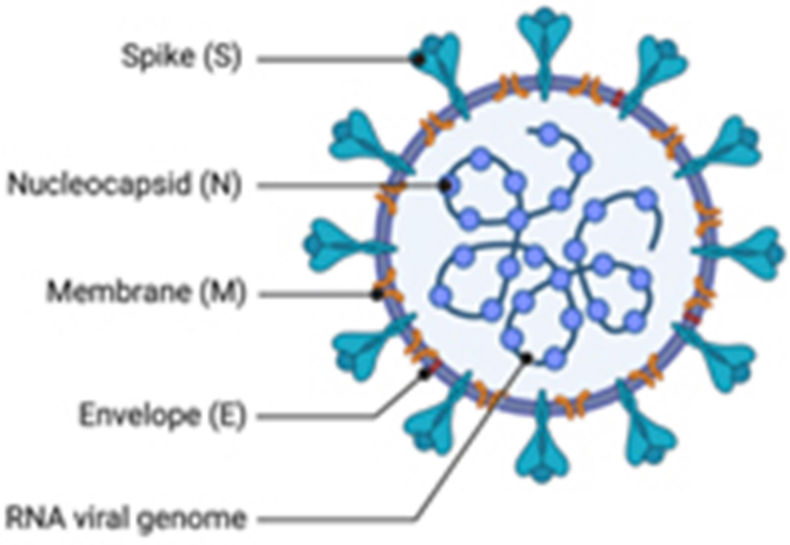

FIGURE 2: Structure of Coronavirus (Li et al., 2016)

TYPES OF CORONAVIRUSES

Alpha, beta, gamma, and delta are the four coronavirus subtypes, and scientists utilise these divisions to classify the various species. Seven coronaviruses have been linked to human disease. Four of these are typical and cause minor infections in the nose, sinuses, throat, lung, upper- and lower- airways. The other three are more likely to result in serious illness. Apart from Covid-19, the coronavirus causing the severe acute respiratory syndrome (SARS-CoV) resulted into the SARS epidemic in 2002–2003 and a Middle East respiratory syndrome coronavirus (MERS-CoV) resulted into MERS outbreak in 2012 were well known (Zhang et al., 2021)

COMMON HUMAN VIRUSES

The four coronaviruses typically cause mild respiratory illnesses, such as the common cold, in humans are: (1) 229E, (2) NL63, (3) OC43, and (4) HKU1. These viruses are common worldwide and account for around 15-30 % of all common colds. They rarely spread to the lower respiratory tract (Zhao et al., 2021).

SARS-CoV

Serious acute respiratory syndrome, or SARS, is brought on by this virus. In 2002, the Chinese province of Guangdong reported the first human cases of this illness. SARS expanded to 26 different nations in total, resulting in a pandemic with more than 8,000 cases. There haven't been any confirmed SARS cases in humans since 2004 (Zhao et al., 2021). SARS symptoms include: fever, fatigue, chills, muscle aches, coughing, difficulty in breathing, and diarrhea.10% of SARS patients die as a result of severe cases of low blood oxygen levels.

MERS-CoV

The Middle East Respiratory Syndrome, or MERS, is brought on by this coronavirus. 2012 saw the onset of the first cases in Saudi Arabia. One-third to one-fourth of those with confirmed MERS pass away from the illness (Zhao et al., 2021). MERS-CoV may be spread through interaction with animals, notably camels (WHO, 2019). Also feasible for human-to-human transmission is close contact with ill persons. For instance, healthcare professionals could be particularly at risk. MERS can result in a fever, cough, and shortness of breath. Most MERS cases since 2012 have occurred in the Middle East. There have been 858 fatalities out of 2494 cases. (Msemburi et al.,

2023) MERS cannot be treated or prevented by vaccines or medications, and health authorities continue to keep a watchful eye on the virus.

SARS-CoV 2

The virus that causes COVID-19 is SARS-CoV-2. 2019 saw the discovery of the first COVID-19 cases in the Chinese city of Wuhan (Zhao et al., 2021). The symptoms of the sickness range from minor to major. The most vulnerable groups to severe COVID-19 are elderly persons and those with underlying medical issues. Common signs and symptoms include: fever, cough, chills, difficulty in breathing, fatigue, body pains, headaches, loss of taste or smell, sore throat, nausea, and diarrhea. One or two of these symptoms may be all that a person with COVID-19 experiences. Not everyone does. Additionally, some patients with the illness may have very minor symptoms, while others have none at all.

MUTATION AND VARIATIONS OF CORONAVIRUS

In order to do that, it's crucial to collect many of samples and sequence the virus's DNA in order to find the change. SARS-CoV 2 can quickly change its structure or its genetic makeup as it spreads, just like any other RNA virus can. a virus with a mutated version of this gene. Through physical touch, it passes from one human body to another. Additionally, there have been more than 50 mutations of the corona virus to date (Zhao et al., 2021). Because of repeated alterations, the virus can quickly adapt to different environments and circumstances and spread illness. However, it is yet unclear if this mutation has an impact on the symptoms that the Covid-19 patient experiences.

SARS-COV-2 mutations

Spreading the numerous SARS-COV-2 variants all share a number of alterations that strengthen them in a growing population while enhancing their replication health. The spike gene is where most of these mutations arise. It is crucial to note the mutation within viral features in order to gain a thorough understanding of SARS-COV-2 variations of concerns and variants of interest. D614G.The D614G point mutation in the spike genome of the SARS-COV-2 virus propagated quickly throughout the population in late February 2020 (Holmes et al., 2021). After some time, it became apparent that almost all Covid19 viruses had this mutation. Initial

studies revealed that this mutation is more harmful and transmissible than the original SARS-COV-2

N501Y

The first emergence of this mutation was seen in United Kingdom and South Africa. N501Y mutation enhances ACE2 proximity and replication of the virus (Holmes et al., 2021). This mutation is on the RBD and the affinity to the host cell receptor is notably increased by this mutation

E484K

The E484K mutation's capacity to resist neutralization may have an impact on antibody-based defenses including monoclonal antibodies and vaccinations. Multiple variations have experienced E484K mutations. It was initially found in the Brazilian version, then in the South African variant (Holmes et al., 2021).

SARS-COV-2 concerning Variants

Variants are classified according to the disease severity and rate of transmission. Both the mutation inside the specific variants and their lineage play a key role in how they are classified. Below is a list of many causes for worry associated with greater transmission, an increase in hospitalization rates, or morbidity.

Alpha Variant

One of the earliest strains of the original SARSCOV-2 to have undergone mutation is the SARS-COV-2 Alpha variant. In the UK, this variation was discovered in September 2020. In order to qualify as a variant of concern, the Alpha variant acquired a number of RBD mutations, including N501Y and P681H at positions 69–70, 144 NTD deletions, and many non–spike mutations (Lednicky et al., 2021; Vlasova et al., 2022).

Beta Variant

As of July 2021, the Beta variety was first discovered in South Africa in May 2020. The nine mutations in the spike protein N501Y, E484K, and K417N are RBD mutations and NTD deletions at positions 242-244 that the Beta variant acquired that made this variant a variant of concern are the main mutations that caused this variant. Numerous studies have discovered partial or complete viral evasion of mAB (Holmes et al., 2021).

Gamma Variant

In January 2021, Brazil reported discovering the first gamma variation . Numerous viral samples taken from sick people were genetically sequenced, and it was shown that the Gamma variety had around 22 mutations total, with about 12 of those occurring on the spike protein. Some examples of RBD mutations are L18F, N501Y, E484K, and K417T (Holmes et al., 2021). Gamma variant NTD mutations have also been found. In comparison to previously found variants, this variant exhibited a 3–4 times greater probability of hospitalisation and morbidity.

Delta Variant

In late 2020, the first Delta variation was discovered in India. The delta variety quickly took over as the predominant strain in many nations. When the Delta variation first emerged, WHO declared that it was the most contagious of the known variants (WHO, 2019). Delta variant has 23 mutations, with the Spike protein E484Q and L452R RBD mutations as well as the P681R cleavage site mutation being the most significant (Holmes et al., 2021). Compared to other varieties, this one has a higher transmission rate and is more contagious.

Omicron

In Nov 2021, this variation was first discovered. Omicron is categorised as a variation of concern because it possesses several unsettling traits. There are more than 50 mutations in this variation, the majority of which are engaged in immune escape or have increased transmissibility. This variant has a large number of mutations and is unrelated to any earlier variants. Scientists have shown that the spike protein contains more than 30 genetic alterations (Holmes et al., 2021). There are a variety of theories about how this variant emerged, but one possibility is that it did so in immunocompromised (like HIV) patients who had the coronavirus for a prolonged period of time, allowing the virus to gradually adapt inside the patient and become better suited to being inside a human's body. The first cases of this variant were discovered in Southern Africa, in Botswana.

SYMPTOMS

The symptoms of COVID-19 differ from person to person. In reality, some sick individuals remain asymptomatic (symptomless). People with Covid-19 typically experience some of the symptoms: exhaustion, cough, shortness of breath or difficulty in breathing, fever or chills, body pains, congestion or runny nose, sore throat, loss of taste or smell, and headache.

Additional symptoms are possible symptoms may appear 2 to 14 days after exposure to the virus. Children have similar, bit usually milder, symptoms than adults (Miyazato et al., 2020). Among disease symptoms are mainly fever, dry cough, shortness of breath. In addition, there may be chills, fatigue, sore throat, nausea, diarrhea, heart problems, such as chest pain or chest tightness and chest palpitations. It usually has many similarities with flu or cold. Symptoms are very early after infection remains, then gradually increases. Sometimes it results in pneumonia and eventually multi-organ failure or death may also occur due to disfigurement of various parts of the body (14%) (Miyazato et al., 2020). And in some cases, the affected person There are no symptoms or they don't feel sick. About 40% of affected people recover without such treatment One in six sufferers may develop a serious respiratory condition. People with compromised immune systems or the elderly (especially those with high blood pressure, heart problems or diabetes) are at greater risk of contracting the virus (Miyazato et al., 2020).

PREVENTION AND CURE

The virus that causes Covid-19, enters your body through your mouth, nose or eyes directly from the air bone droplets or from the transfer of the virus from your hand to your face. It then travels to the back of your nasal passage and mucous membrane in the back of your throat. It attaches to cells, there begins to multiply and moves into lung tissue. From there, the virus can spread to the body tissues. Method of Identification of Corona Virus samples for this test can be collected virtually anywhere. Usually, a cotton swab is inserted into the patient's throat, saliva is collected and sent to the laboratory. In this exempted rapid test, material is also tested to detect the presence of antibodies (Singhal et al., 2020). For example**,** Feluda is one of the rapid antibody test kits invented in India**.** While the process of collecting the sample is simple, the process of testing it in the

laboratory is quite complex. Reverse Transcriptase Polymerase Chain Reaction (PCR) is performed with the sample to detect any polymerase chain reaction (PCR) that occurs on the cell's DNA. But, since the corona virus is an RNA virus, the first step of the test is to convert the RNA into DNA if the virus is present in the sample taken from the patient's body. The DNA is then replicated multiple times in the PCR method, and the presence of the virus in the sample can be easily determined from the transcripts produced. In that case, the affected person is called corona positive. And if there is no virus, no replication is made. In that case, the affected person is called corona negative. It takes 24 hours to get the test-Method of Prevention of Coronavirus (Singhal et al., 2020):

1. Social distancing and the corona virus can exist in a person's body for more than two weeks without any symptoms. If a person carrying such a coronavirus sneezes or coughs for any reason, the virus can enter the surrounding air through aerosol particles that dire need of air circulation and normal breathing of any other person within the perimeter carry the coronavirus within 3 to 6 feet. Because of this, crowded, such areas are in If not, it should be avoided as much as possible (WHO, 2020).
2. Always try to keep hands clean. Wash your hands thoroughly with soap at regular intervals. Wash palms, fingers and wrists thoroughly with soap (at least for twenty seconds). Hands should be washed repeatedly even if dirt is not visible. Hands should be washed in particular after caring for an infected person, after sneezing or coughing, before cooking food, before serving food, after using the bathroom, and after handling animals.
3. Sanitizer to be used for cleaning hands, alcohol content should be 70% to 95% (Singhal et al., 2020).
4. Mask should be worn in case of sneezing, runny nose.
5. Avoid touching nose and mouth as much as possible throughout the day. Because we mainly work with our hands, we touch a lot of things throughout the day from which the virus can get on our hands. Therefore, unclean hands should never touch the nose, mouth and eyes.
6. At least one meter distance should be maintained from people who have cold-cough fever. Because like all viruses, this disease is transmitted through cold

droplets or particles. Apart from this, contact with people who are already infected should also be avoided. Stay away from sick animals.

7. If a handkerchief or tissue paper is not at hand, do not cough or sneeze with your handover your mouth as that hand is likely to touch something else. Instead, sneeze or cough with your mouth close to your elbow or shoulder.
8. When sneezing or coughing, after using the tissue paper do not throw the tissue paper where it is, any specific Dispose in a covered dustbin.
9. Care should be taken while cooking the food so that it is well cooked (WHO, 2020).
10. Stay home if you feel sick. If it is necessary to go out, a mask should be used to cover the name and face. However, if you feel very sick, if you have fever, cough or shortness of breath, you should go to the nearest doctor immediately. He will look into the matter and ask for tests if necessary. That is, being aware of your own symptoms, you should prevent yourself from going out of the house as needed and keep a distance from other members at home(self-isolation) or report to the doctor (safe reporting).
11. Abstain from traveling abroad except for urgent needs. Urgent precautions should be taken in case of essential travel.
12. If anyone knows for any reason that they have come in contact with a patient with covid-19, even if they have no symptoms. He must be isolated from others for 14 days. This is called safe quarantine.
13. Care should be taken when greeting someone. Greet someone by bowing without shaking hands (handshake) or cooing (Singhal et al., 2020).

Adenoviruses

ORIGIN OF ADENOVIRUS

Adenoviruses are a group of viruses that can infect various animals, including humans. They were first isolated and identified in the early 1950s. The term "adenovirus" comes from the Greek word "aden," meaning gland, as these viruses were initially discovered in the adenoid tissue of humans. The discovery and characterization of adenoviruses involved the work of multiple researchers. One of the key figures in this field was Dr. Wallace P. Rowe, who played a significant role in isolating and studying these viruses. Dr. Rowe and his colleagues identified and classified different serotypes (variations) of adenoviruses based on their ability to agglutinate red blood cells.

Adenoviruses have since been extensively studied for various purposes, including their use as vectors in gene therapy and vaccine development due to their ability to efficiently infect human cells and provoke an immune response. They are also commonly used in laboratory research to study cellular processes and viral infection mechanisms. It's important to note that adenoviruses have a diverse range of serotypes that can cause various illnesses, including respiratory infections, gastroenteritis, and conjunctivitis, among others. While some adenovirus serotypes can cause mild illnesses, others can lead to more severe disease, especially in individuals with weakened immune systems.

STRUCTURE OF ADENOVIRUS

The linear, double-stranded DNA genome is housed in the protein core of the adenovirus particle, which is enclosed by an icosahedral protein shell. The shell has 252 structural capsomeres and has a diameter of between 70 and 100 nm (Brown et al., 1975). Units called pentons, each of which has a thin projection termed a fiber, occupy the icosahedron's 12 vertices. Hexons are the 240 capsomeres that make up the icosahedron’s 20 faces and edges and create hexagonal arrays. (Brown et al., 1975) The shell additionally includes a few more, small polypeptide components. Polypeptides V and VII, two important proteins, and a smaller arginine-rich protein make up the core of the particle. The 5′ ends of the DNA are covalently joined by a 55 kDa protein (Brown et al., 1975).

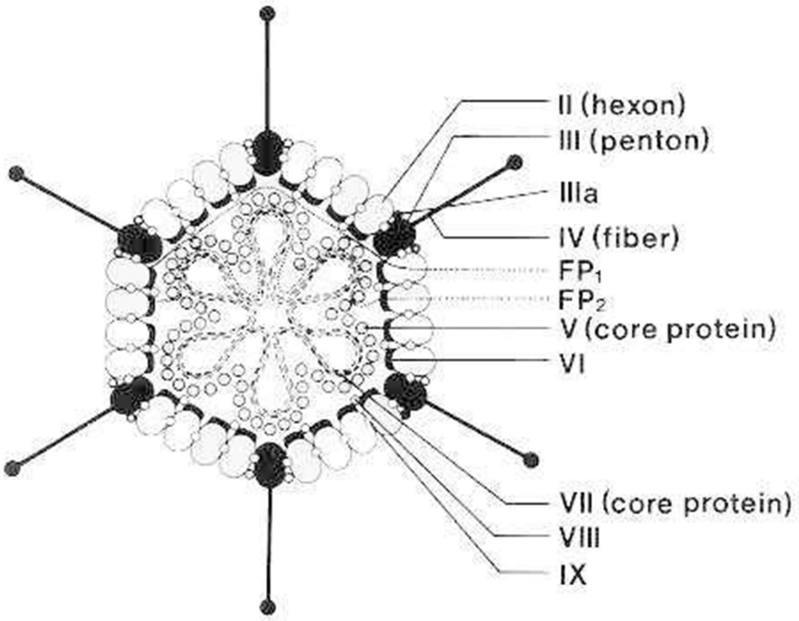

Figure 3: Structural model of the adenovirus virion (Brown et al., 1975). The Roman numerals refer to the standard designations of the viral structural proteins according to their decreasing molecular masses. FP stands for fracture plane in freeze etching.

SYMPTOMS

Depending on the area of your body the virus infects, you may have different signs and symptoms of an adenovirus infection. Your respiratory system is typically infected by the virus (Edwards et al., 1985). Adenovirus infections in the respiratory tract can produce symptoms that are comparable to the flu or the common cold. Conditions or signs you might suffer include: cough, fever, a stuffy nose, pharyngitis (throat infection), conjunctivitis (pink eye), medial otitis (ear infection), lymph node swelling, bronchitis (a chest infection), and pneumonia.

Your digestive system can be impacted by adenoviruses as well. Diarrhea may be brought on by a gastrointestinal infection. Also possible is gastroenteritis. Inflammation of the stomach or intestines is known as gastroenteritis. It may result in nausea, vomiting, diarrhea, and stomach pain (Edwards et al., 1985).

Adenoviruses can more rarely harm your neurological system or bladder. Urinary tract infections can be brought on by viruses in your bladder. Your nervous system can develop illnesses from viruses that can harm your brain. Meningitis and encephalitis are

two examples of these ailments. Adenovirus symptoms typically last a few days to as long as two weeks. Infections that are severe could last longer. You can experience symptoms like a cough that last for a time (Cruz et al., 2019).

TYPES OF ADENOVIRUSES

Adenoviruses are typical infections that affect both people and animals. In addition, a number of strains have undergone extensive study and are employed as tools in mammalian molecular biology. Adenoviruses come in more than 100 serologically different varieties, 49 of which can infect people (Scott et al., 2016). Mammalian (mastadenoviruses) and avian (aviadenoviruses) adenoviruses make up the two Genera of the family Adenoviridae. The human adenoids, from which the adenoviruses were initially isolated, bear their name. A number of adenoviruses can cause conjunctivitis and respiratory illnesses. In addition, some human adenovirus varieties can change some rodent and human cell cultures and cause undifferentiated sarcomas in newborn hamsters and other rodents. Although there is now no proof that adenoviruses cause cancer in people, the concept is nonetheless intriguing.

Table 1: Types of adenoviruses (Zhang et al, .2017)

Adenovirus type	Homology to HAdV-5	Interaction factors known (adapted from [10])	Type of infection / Predominant natural tropism (adapted from [1])	Vector construction strategy	Milestone/Feature/Highlight
HAdV-12	61%	CAR	Gastrointestinal, respiratory, urinary	HRB [55]	Highly oncogenic with the ability to induce tumors in new born rodents [60]
HAdV-18	61%				
HAdV-31	61%				
HAdV-3	64%	CD46, DSG2, HSPG, CD80/86, integrins	Keratoconjunctivitis, gastrointestinal, respiratory, urinary	HRB [50, 55]	Human clinical trial as oncolytic vector [61]
HAdV-7	65%	CD46, DSG2, CD80/86, HSPG		HRE [25], CBM [62], HRB [55]	The first vectorized non-HAdV-C serotype [25]; Reliable safety track record of the wild-type HAdv-7 vaccine [63]
HAdV-16	64%	CD46		HRB [55]	Enhanced cardiovascular tissue transduction [64]
HAdV-21	64%	CD46			
HAdV-50	64%	CD46, CD80/86		CBM & HRE [31]	Rare human serotype; increased myogenic cell transduction [65]
HAdV-11	63%	CD46, DSG2, CD80/86	Gastrointestinal, respiratory, urinary	HRB [38, 55], CBM & HRE [26]	As oncolytic vector and gene transfer vector [66]
HAdV-14	63%	CD46		HRB [55]	
HAdV-34	63%	CD46			
HAdV-35	63%	CD46, DSG2, HSPG, CD80/86, integrins		TMC [27, 28], CBM & HRE [67], HRE [68], HRB [39, 55]	Efficient gene transfer into human hematopoietic stem cells [27]; broadly explore vaccine vector [69]
HAdV-1	94%			HRB [55]	
HAdV-2	94%	CAR, integrin, HSPG, FX, Lf,	Respiratory, gastrointestinal including hepatitis, urinary	TMC [29], HRB [34, 55]	Airway epithelial transduction vector [29]
HAdV-5	100%			TMC & HRE [30] HRB [36, 44, 45, 47, 55]	The best studied and the most used adenoviral vector [70]
HAdV-6	94%			HRB [37, 55]	The least prevalent species C virus in humans [37]
HAdV-8	64%	SA	Keratoconjunctivitis, gastrointestinal	HRB [55]	Cause more severe conjunctivitis [1]
HAdV-9	65%	CAR			
HAdV-10	65%				
HAdV-13	65%				
HAdV-17	64%	CAR, CD46, FX			
HAdV-19	65%	SA (Ad19a); CAR (Ad19p)		HRB [51]	Promising lymphoid and muscle cells targeting [51]
HAdV-20	64%			HRB [55]	

PREVENTION AND CURE

By defending your family and yourself, you can lower your risk of contracting an adenovirus infection (Scott et al., 2016):

- One technique to prevent infections in crowded places is to wear a face mask. Alcohol hand sanitizer can also be used to inhibit the spread of germs.
- The medical professionals advise soap hand cleaning.
- Due to the increased risk of infection from adenovirus, everyone is urged to avoid crowded areas and social gatherings.
- Doctors also recommend checking infants and children if symptoms are noticed right away.
- The West Bengal government has sent district hospitals health alerts outlining the procedures that must be taken promptly to treat infected people and prevent sickness.
- Frequently wash your hands with soap and water. at least 20 seconds to wash.
- If you haven't washed your hands, don't touch your mouth, nose, or eyes.
- Try to avoid being around sick individuals.
- Regularly wash and sanitize your child's toys.
- Use a solution of bleach and water to clean worktops, sinks, and other hard surfaces.

Take action to stop the spread of the adenovirus if you are already ill. If you're sick, stay at home to protect others.

- Coughing and sneezing into a tissue or your elbow. Never sneeze or cough into your hand.
- Not using other people's plates, glasses, towels, or pillows as your own.
- Maintaining a safe distance from others. Do not embrace or kiss.
- Frequently washing your hands.

The majority of adenovirus infections will go away on their own rapidly. But it's crucial to contact your doctor if you or your child exhibit any of the following signs: (Scott et al.,2016)

- A fever lasting more than five days or one that is higher than 104°F (40°C).
- Trouble breathing.

- Hydration loss.
- A decline in activity or attentiveness.
- Lack of sleep or fussiness.

The general public does not presently have access to any adenovirus vaccines. For specific viral kinds, the military utilizes a vaccination. The vaccine is only given to service members who have a higher risk of illness. The vaccine has not been given FDA approval for usage outside of the military. A live virus that can be excreted in stool is present in the adenovirus vaccine. This indicates that it can be expelled from your body. The virus can sicken other people if it is spread. The vaccine's effectiveness and safety in the general population have not yet been investigated by researchers. Additionally, it hasn't been tried on those with compromised immune systems (Scott et al., 2016)

THE DIFFERENCE BETWEEN ADENOVIRUS AND CORONAVIRUS

Since adenoviruses and coronaviruses both cause infections, it can be challenging to distinguish between the two. Both can be spread by direct contact or breathing droplets. Both are capable of causing serious respiratory tract infections. Adenoviruses, however, are able to survive longer than coronaviruses because of their increased resistance to anti microbials (Foster et al., 1996). The envelope, a second layer, covers the capsid, the protein shell of coronaviruses. The virus is shielded by the envelope, a membrane comprised of lipids and proteins, when it is outside of its host cell. Spike proteins can be observed emerging from coronavirus's envelopes, resistant to disinfectants because there isn't an envelope.There is no additional envelope covering the capsid of adenoviruses. They are more resistant to disinfectants because there isn't an envelope (Foster et al., 1996).

Proteins that bind to the envelopes of coronaviruses and other enveloped viruses. The proteins that made the envelopes infectious are lost when they degrade. They become less resistant to disinfectants as a result. Proteins are directly bound to the capsids of adenoviruses and other non-enveloped viruses. The capsids maintain their integrity and are more resistant to cleaners (Foster et al., 1996).

Denguevirus

ORIGIN OF DENGUE VIRUS

In tropical, subtropical, and temperate regions of the world throughout the past three centuries, dengue outbreaks are known to have happened. Although a sickness similar to dengue had been observed in China as early as 992 AD, the first dengue outbreak was documented in 1635 in the French West Indies (Howe et al., 1977). In the tropics and in certain temperate areas, epidemics of infections similar to dengue were documented during the 18th, 19th, and early 20th centuries (Howe et al., 1977). When Rush wrote about "break-bone fever" happening in Philadelphia in 1780, he was probably discussing dengue (Howe et al., 1977). Although some were linked to the severe hemorrhagic form of the disease, most of these epidemics were clinical dengue fever. Over the past 50 years, efforts to manage Aedes aegypti and economic growth have significantly lessened the threat of epidemic dengue in temperate nations. Australia experienced the first known outbreak of a dengue illness related to DHF in 1897 (Howe et al., 1977). A similar hemorrhagic sickness was discovered in Taiwan in 1931 and during an epidemic in Greece in 1928. In the Philippines, there was the first known DHF pandemic between 1953 and 1954 (Howe et al., 1977). The majority of the South-East Asian nations, including India, Indonesia, the Maldives, Myanmar, Sri Lanka, and Thailand, as well as Singapore, Cambodia, China, Laos, Malaysia, New Caledonia, Palau, the Philippines, Tahiti, and Vietnam in the Western Pacific Region, have since experienced significant DHF outbreaks with high mortality rates. The prevalence and geographic distribution of DHF have dramatically increased during the past 20 years, and epidemics now happen annually in some South-East Asian nations (Howe et al., 1977).

STRUCTURE OF DENGUE VIRUS

The family Flaviviridae and genus Flavivirus both contain the dengue viruses. These single-strand RNA-containing viruses are only 50 nm in size. The nucleocapsid of the virion has cubic symmetry and is encased in a lipoprotein envelope. The dengue virus genome is around 11,000 base pairs long and contains seven nonstructural protein (NS) genes in addition to three structural protein genes that code for the nucleocapsid or core protein (C), a membrane-associated protein (M), and an envelope protein (E). (Schaffner et

al., 2014) The viral hemagglutination and neutralization activity of the envelope glycoprotein are related. Based on antigenic and biological traits, the dengue viruses form a unique complex within the genus Flavivirus. There are four different viral serotypes, known as DEN-1, DEN-2, DEN-3, and DEN-4 (Schaffner et al., 2014). Any one viral serotype offers lifetime immunity upon infection with that virus serotype. Despite the antigenically similarity between all four serotypes, only a few months after infection with any one of them does cross-protection occur. There have been dengue fever epidemics with little to no DHF evidence linked to dengue viruses of all four serotypes. Each of the four viral serotypes has also contributed to DHF epidemics linked to serious and lethal illnesses (Schaffner et al., 2014).

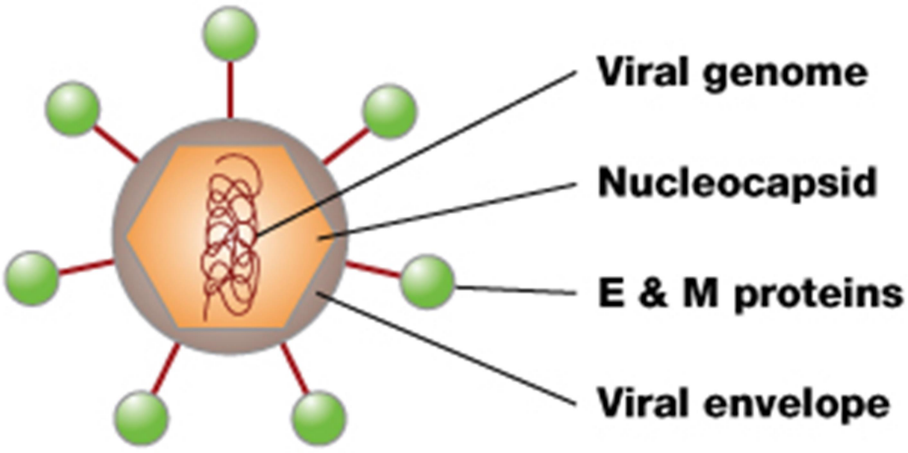

FIGURE 4: Structure of Dengue Virus (Santra et al., 2020)

SYMPTOMS OF DENGUE VIRUS

The majority of dengue patients have minimal or no symptoms and recover in one to two weeks. Rarely, dengue can be fatal due to its severity. When they do, symptoms often appear 4–10 days after infection and continue for 2–7 days (Rush et al., 1951). Some of the signs could be: rash, high fever (104°F/40°C), terrible headache, eye discomfort, joint and muscle pains, nausea, vomiting, swollen glands, and pain behind the eyes. Severe dengue is more likely to affect people who have already been infected once. Strong dengue symptoms frequently appear after the fever has subsided: excruciating stomach pain, frequent vomiting, quick breathing, bleeding gums or nose, exhaustion, blood in the vomit

or stool, extreme thirst, pale and chilled skin, a weak sensation. People who have had dengue may have fatigue for several weeks after recovering (Rush et al., 1951).

TRANSMISSION OF DENGUE VIRUS

Transmission by a mosquito sting

The virus spreads to people when infected female mosquitoes, primarily the Aedes aegypti mosquito, bite them. Although other Aedes genus species are capable of acting as vectors, Aedes aegypti is the primary contributor. The virus reproduces in the mosquito's midgut after it feeds on a host with DENV infection before spreading to secondary tissues, such as the salivary glands. The extrinsic incubation period (EIP) refers to the duration of time between consuming the virus and actually transmitting it to a new host. When the outside temperature is between 25 and 28 °C, the EIP takes approximately 8 to 12 days. The magnitude of daily temperature changes, the virus genotype, and the initial viral concentration are a few more variables that affect the extrinsic incubation period and can affect how long it takes a mosquito to transmit a virus. The mosquito can continue to spread the virus for the remainder of its life if it becomes infected (Howe et al., 1977).

Human-to-mosquito transmission

People with DENV virus infections can spread the disease to mosquitoes. Asymptomatic individuals are those who do not exhibit any symptoms of sickness, pre-symptomatic individuals who have not yet developed symptoms of dengue, and symptomatic individuals. Up to 2 days before an individual exhibits symptoms of the sickness and up to 2 days after the fever has subsided, human-to-mosquito transmission is possible (Howe et al., 1977). High levels of the patient's viremia and fever are favourably correlated with the likelihood of mosquito infection; on the other hand, high levels of DENV-specific antibodies are negatively correlated with the risk of mosquito infection. Although viremia can persist up to 12 days, most patients are only viremic for about 4–5 days (Howe et al., 1977).

Mother-to-child transmission

Mosquito vectors are the main means of DENV transmission between people. However, there is evidence suggesting that a pregnant woman could transmit the disease to her unborn child. The danger of vertical transmission appears to be related to the timing of the dengue infection during pregnancy, however vertical transmission rates appear to be

minimal. Babies may have preterm birth, low birthweight, and foetal distress when a mother has a DENV infection while she is pregnant (Howe et al., 1977).

Other types of transmission

Rare instances of transmission by transfusions, organ donation, and blood products have been documented. Similar to this, records of the virus's transovarial transmission within mosquitoes exist as well (Howe et al., 1977).

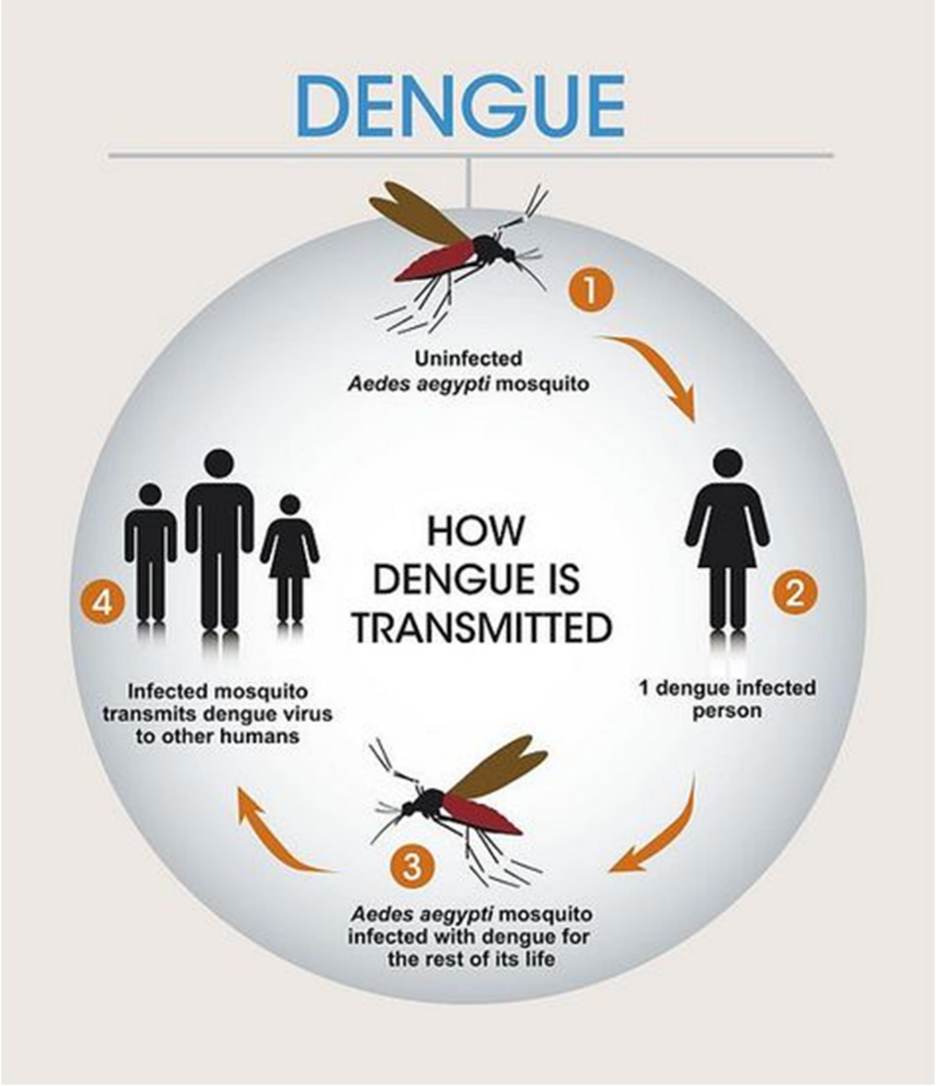

FIGURE 5: Transmission of dengue (Sah et al., 2023)

PREVENTION AND CONTROL

The dengue-transmitting mosquitoes are active during the day. According to Kanwar et al. (2017), using the following measures to reduce your exposure to mosquito bites, can reduce your risk of contracting dengue:

- Wearing clothing that covers as much of your body as possible
- Using mosquito nets
- Insect repellent-sprayed nets
- When sleeping during the day using window screens
- Using coils and vaporizers.

Rest, drink plenty of fluids, take paracetamol (paracetamol) for discomfort, avoid non-steroidal anti-inflammatory drugs like ibuprofen and aspirin, watch for severe symptoms, and get in touch with your doctor right away if you experience any if you contract dengue. One vaccine (Dengvaxia) has so far received approval and licencing in several nations. However, this vaccination can only provide protection to people who have a history of dengue infection. Additional dengue vaccine candidates are being assessed (Kanwar et al., 2017).

The majority of dengue fever cases can be managed with painkillers at home. The easiest approach to avoid having dengue is to avoid mosquito bites. Dengue does not have a specific treatment. Treatment of pain symptoms is the main priority. To manage pain, Acetaminophen (paracetamol) is frequently used. Ibuprofen and aspirin are two non-steroidal anti-inflammatory medications that should be avoided since they raise the chance of bleeding (Kanwar et al., 2017). For those who have experienced dengue at least once and reside in areas where the illness is widespread, there is a vaccine called Dengvaxia. Hospitalization is frequently required for those with severe dengue.

CONCLUSION

Despite the fact that the SARS-CoV2 animal host has not yet been discovered, a large body of data suggests that the virus is zoonotic. Even though it is impossible to completely rule out laboratory errors, it may be inferred from the most recent studies that the formation of SARS-CoV-2 was most likely caused by natural adaptation. It is crucial to carry out thorough studies on the origin of COVID-19 through close international partnerships. If not, the globe will continue to be susceptible to future pandemics of dangerous infectious illnesses.

In immunosuppressed patients, adenovirus is linked to a wide range of clinical illnesses with high attributable morbidity and mortality. Nucleic acid testing has become a key technique for directing patient management and antiviral drug treatment, serving largely as a surveillance tool to enable preventive antiviral therapy. Patients who have been diagnosed with adenovirus disease should, whenever feasible, be treated in consultation with a specialist in infectious diseases of immunocompromised hosts because the management of these patients has not been prospectively investigated.

Dengue fever still poses a hazard to global health and public safety. As of right now, it is endemic and manifests itself as an epidemic at suitable times and locations throughout practically the whole tropics. While we wait for additional vaccines, antiviral medications, and enhanced diagnostics, prudent and judicious use of currently existing therapies should be started. How we use these more modern instruments will be the future problem. A global strategy has been promoted that uses integrated vector management along with early and accurate diagnosis to increase the capacity for surveillance and outbreak response, alter behavior, and lower the disease burden. Future advancements in the development of antiviral medications and vaccines may also have a significant impact on dengue management.

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